backup fire pumps. There would also be diesel fuel and gasoline to fuel vehicles during the construction, operation and monitoring, and closure of the repository. In addition, fossil-fuel powered vehicles would maintain the excavated rock storage area.

2.1.2.2 Repository Subsurface Facilities and Operations

DOE would construct the subsurface facilities of the repository and emplace the waste packages above the water table in a mass of volcanic rock (referred to as the *repository block*) known as the Topopah Spring Formation, which consists of *welded tuff* (see Chapter 3, Section 3.1.3.1). The specific area in this formation where DOE would build the repository emplacement drifts would satisfy several criteria: (1) to be in select portions of the Topopah Spring Formation that have desirable properties, (2) to avoid major faults for reasons related to both hydrology and *seismic* hazards (see Section 3.1.3.2), (3) to be at least 200 meters (660 feet) below the surface (DIRS 154554-BSC 2001, Section 4.2.1.2.9, p. 29), and (4) to be at least 160 meters (530 feet) above the present-day water table (DIRS 154554-BSC 2001, Section 4.2.1.2.4 p. 28).

The flexible design would use part or all of the layout shown in Figure 2-13. The smallest area that DOE would use is the shaded area that corresponds to the higher-temperature repository operating mode. DOE would use the full area shown for some of the possible lower-temperature repository operating modes (DIRS 153849-DOE 2001, Section 2.1.5.1).

The higher-temperature operating mode would utilize the upper (primary) block of the repository, using 4.7 square kilometers (1,150 acres) (DIRS 153849-DOE 2001, Section 2.3.1.1) (see Figure 2-13) and would require seven emplacement and development ventilation shafts. The lower-temperature repository operating mode could require as many as 17 ventilation shafts (see Table 2-2).

2.1.2.2.1 *Subsurface Facility Design and Construction*

The subsurface design would incorporate most of the drifts developed during the site characterization activities. Other areas would be excavated during the repository construction phase. Excavated openings would include gently sloping access ramps to enable rail-based movement of construction and waste package handling vehicles between the surface and subsurface, subsurface main drifts to enable the movement of construction and waste package handling vehicles, emplacement drifts for the placement of waste packages, exhaust mains to transfer air in the subsurface area, and ventilation shafts to transfer air between the surface and the subsurface. There would also be performance confirmation (observation) drifts for the placement of instrumentation to monitor emplaced waste packages (see Figure 2-13).

Access ramps connecting the surface and subsurface would be concrete-lined, 7.6-meter (25-foot)-diameter tunnels excavated by electric-powered tunnel boring machines (see Figure 2-14). Rail lines and an overhead trolley system would enable the movement of electric-powered construction and waste package handling vehicles. DOE developed the North and South Ramps, which would become part of the proposed repository, during site characterization. The North Ramp begins at the North Portal Operations Area on the surface (see Section 2.1.2.1.1) and extends through the subsurface to the edge of the repository area. It would support waste package emplacement operations. The South Ramp originates at the South Portal Development Area on the surface (see Section 2.1.2.1.2) and extends through the subsurface to the edge of the repository area. It would support subsurface construction and development activities.

The main drifts for the higher-temperature repository operating mode would include the East Main, the West Main, and the North Main. These drifts would be extended for the lower-temperature operating modes and additional main drifts would be excavated to provide access to other emplacement areas.

Main drifts would be concrete-lined, 7.6-meter (25-foot)-diameter tunnels excavated by tunnel boring machines. Rail lines and an overhead trolley system in the main drifts would enable the movement of electric-powered construction and waste package handling vehicles. The East Main drift was excavated as part of site characterization activities but was not lined with concrete. During the operation and monitoring phase, the main drifts would support both subsurface development and waste package emplacement, which would occur simultaneously. Ventilation barriers creating airlocks would separate the emplacement and development sides of the repository, and the ventilation system would maintain the emplacement side at a lower pressure than the development side. This would ensure that any air transfer would be from the development side to the emplacement side.

The flexible design is based on an emplacement drift spacing of approximately 81 meters (266 feet) (DIRS 153849-DOE 2001, Section 2.3.1.1). Emplacement drifts would be 5.5-meter (18-foot)-diameter tunnels connecting the main drifts; they could have steel ribbing. These drifts would be excavated by an electric-powered tunnel boring machine. Remotely operated steel isolation doors at the emplacement drift entrances would prevent unauthorized human access and reduce radiation exposure to personnel.

As noted above, tunnel boring machines would excavate the emplacement drifts and most main drifts. DOE would use other mechanical excavators in areas where tunnel boring machines were impractical (for example, excavating turnouts and small alcoves) or industry-standard drill and blast techniques in limited applications where mechanical excavators were impractical. Ventilation shafts [8.0 meters (26 feet) in diameter] would be excavated from the surface to the repository using mechanical or drill-and-blast techniques. (DIRS 153849-DOE 2001, p. 2-95). Specialized equipment would move excavated rock in the subsurface to the conveyor system that would move the rock to the excavated rock storage area on the surface. During drift excavation, water supplied to the subsurface in pipelines would be used for dust control at the excavation location and along the conveyor carrying excavated rock. Some of the water would be removed from the subsurface with the excavated rock, some would evaporate and be removed in the ventilation air, and the remainder would be collected in sumps near the point of use and pumped to the evaporation pond at the South Portal. DOE could recycle the water discharged to the evaporation pond for surface dust suppression activities. Controls would be established, as necessary, to ensure that water application for subsurface (and surface) dust control would not affect repository performance.

2.1.2.2.2 *Ventilation*

The repository design uses ventilation shafts to provide airflow to the subsurface during construction, emplacement, and performance monitoring. It also provides positive pressure ventilation flow for the construction and development of the repository and negative pressure ventilation flow in the emplacement drifts. Further, the design includes monitoring for radioactive contamination and preventive measures to achieve mitigation against the spread of such contamination. The development side would be isolated from the emplacement side. Table 2-2 lists the number of ventilation shafts and flow rates.

The flexible design uses an emplacement drift forced-air ventilation rate of 15 cubic meters (530 cubic feet) per second in each emplacement drift to control temperatures in the rock between the emplacement drifts, at the drift wall, and at the waste package surface to meet thermal goals. Figure 2-12 shows the general airflow pattern for ventilation of the emplacement drifts under the higher-temperature repository operating mode, using a representative section of a fully developed repository. In the basic ventilation design, fresh air would enter through the surface ends of intake shafts and ramps and would flow to the East and West Mains. From the mains, air would enter the emplacement, performance confirmation, or reserve drifts and flow to exhaust raises near the center of each drift. The exhaust raises would direct the airflow down to the exhaust main, where it would continue to an exhaust shaft and then to the surface.